WE CLAIM:

1. A process of liquefying a gaseous, methane-rich feed to a liquefied product, said liquefaction process comprising the steps of:

(a) providing the gaseous, methane-rich feed at elevated pressure to a first tube side of a main heat exchanger at its warm end, cooling, liquefying and sub-cooling the gaseous, methane-rich feed against evaporating refrigerant to get a liquefied stream, removing the liquefied stream from the main heat exchanger at its cold end and passing the liquefied stream to storage as liquefied product;

(b) removing evaporated refrigerant from the shell side of the main heat exchanger at its warm end;

(c) compressing in at least one refrigerant compressor the evaporated refrigerant to get high-pressure refrigerant;

(d) at least partly condensing the high-pressure refrigerant and separating in a separator the partly-condensed refrigerant into a liquid heavy refrigerant fraction and a gaseous light refrigerant fraction;

(e) sub-cooling the heavy refrigerant fraction in a second tube side of the main heat exchanger to get a sub-cooled heavy refrigerant stream, introducing the heavy refrigerant stream at reduced pressure into the shell side of the main heat exchanger at its mid-point, and allowing the heavy refrigerant stream to evaporate in the shell side; and

(f) cooling, liquefying and sub-cooling at least part of the light refrigerant fraction in a third tube side of the main heat exchanger to get a sub-cooled light refrigerant stream, introducing the light refrigerant stream at reduced pressure into the shell side of the main heat exchanger at its cold end, and allowing the light refrigerant stream to

evaporate in the shell side, the process further comprising adjusting the composition and the amount of refrigerant and controlling the liquefaction process, using an advanced process controller based on model predictive control to determine simultaneous control actions for a set of manipulated variables in order to optimize at least one of a set of parameters whilst controlling at least one of a set of controlled variables, wherein the set of manipulated variables includes the mass flow rate of the heavy refrigerant fraction, the mass flow rate of the light refrigerant fraction, the amount of refrigerant components make-up, the amount of refrigerant removed, the capacity of the refrigerant compressor and the mass flow rate of the methane-rich feed, wherein the set of controlled variables includes the temperature difference at the warm end of the main heat exchanger, a variable relating to the temperature of the liquefied natural gas, the composition of the refrigerant entering the separator of step (d), the pressure in the shell of the main heat exchanger, the pressure in the separator of step (d) and the level of the liquid in the separator of step (d), and wherein the set of variables to be optimized includes the production of liquefied product.

2. The process of claim 1 wherein the set of controlled variables further includes the first mid point temperature difference.

3. The process of claim 2 wherein the set of controlled variables further includes the second mid point temperature difference.

4. The process of claim 1 wherein the set of controlled variables further includes the temperature of the gas being liquefied in the first tube side at the midpoint.

5. The process of claim 2 wherein the set of controlled variables further includes the temperature of the gas being liquefied in the first tube side at the midpoint.

6. The process of claim 3 wherein the set of controlled variables further includes the temperature of the gas being liquefied in the first tube side at the midpoint.

7. The process of claim 1 wherein the variable relating to the temperature of the liquefied natural gas is the temperature of the liquefied natural gas removed from the main heat exchanger.

8. The process of claim 2 wherein the variable relating to the temperature of the liquefied natural gas is the temperature of the liquefied natural gas removed from the main heat exchanger.

9. The process of claim 4 wherein the variable relating to the temperature of the liquefied natural gas is the temperature of the liquefied natural gas removed from the main heat exchanger.

10. The process of claim 1 further comprising reducing the pressure of the liquefied stream to get the liquefied product which is passed to storage and an off-gas, and the variable relating to the temperature of the liquefied natural gas is the amount of off-gas.

11. The process of claim 2 further comprising reducing the pressure of the liquefied stream to get the liquefied product which is passed to storage and an off-gas, and the variable relating to the temperature of the liquefied natural gas is the amount of off-gas.

12. The process of claim 4 further comprising reducing the pressure of the liquefied stream to get the liquefied product which is passed to storage and an off-gas, and the variable relating to the

temperature of the liquefied natural gas is the amount of off-gas.

13. The process of claim 1 wherein adjusting the amount of refrigerant comprises venting gaseous refrigerant.

14. The process of claim 2 wherein adjusting the amount of refrigerant comprises venting gaseous refrigerant.

15. The process of claim 4 wherein adjusting the amount of refrigerant comprises venting gaseous refrigerant.

16. The process of claim 7 wherein adjusting the amount of refrigerant comprises venting gaseous refrigerant.

17. The process of claim 10 wherein adjusting the amount of refrigerant comprises venting gaseous refrigerant.

18. The process of claim 1 wherein adjusting the amount of refrigerant comprises draining liquid refrigerant.

19. The process of claim 2 wherein adjusting the amount of refrigerant comprises draining liquid refrigerant.

20. The process of claim 4 wherein adjusting the amount of refrigerant comprises draining liquid refrigerant.

21. The process of claim 7 wherein adjusting the amount of refrigerant comprises draining liquid refrigerant.

22. The process of claim 10 wherein adjusting the amount of refrigerant comprises draining liquid refrigerant.

23. The process of claim 1 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane

content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

24. The process of claim 2 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

25. The process of claim 4 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

26. The process of claim 7 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

27. The process of claim 10 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

28. The process of claim 13 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen

content is minimized and the propane content is maximized.

29. The process of claim 18 wherein the refrigerant includes nitrogen and propane, and the set of variables to be optimized further includes the nitrogen content of the refrigerant and the propane content of the refrigerant, wherein the nitrogen content is minimized and the propane content is maximized.

30. The process of claim 1 wherein the set of controlled variables further includes the power required to drive the refrigerant compressor(s).

31. The process of claim 2 wherein the set of controlled variables further includes the power required to drive the refrigerant compressor(s).

32. The process of claim 23 wherein the set of controlled variables further includes the power required to drive the refrigerant compressor(s).

33. The process of claim 1 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

34. The process of claim 2 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

35. The process of claim 4 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

36. The process of claim 7 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of

the inlet guide vane of the refrigerant compressor, or both.

37. The process of claim 10 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

38. The process of claim 13 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

39. The process of claim 18 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

40. The process of claim 23 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

41. The process of claim 24 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

42. The process of claim 30 wherein the manipulated variable capacity of the refrigerant compressor is the speed of the refrigerant compressor, the angle of the inlet guide vane of the refrigerant compressor, or both.

43. The process of claim 1 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a

suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

44. The process of claim 2 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

45. The process of claim 3 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

46. The process of claim 4 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

47. The process of claim 7 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

48. The process of claim 10 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the

set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

49. The process of claim 13 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

50. The process of claim 18 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

51. The process of claim 23 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange

with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

52. The process of claim 25 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

53. The process of claim 27 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

54. The process of claim 30 wherein partly condensing the high-pressure refrigerant is done in at least one heat exchanger by means of indirect heat exchange with auxiliary refrigerant evaporating at a

suitable pressure, and wherein evaporated auxiliary refrigerant is compressed in at least one auxiliary refrigerant compressor and condensed by heat exchange with an external coolant, and the set of manipulated variables further includes the capacity of the auxiliary refrigerant compressor(s), and in that the set of controlled variables further includes the power required to drive the auxiliary refrigerant compressor(s).

55. The process of claim 1 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

56. The process of claim 2 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

57. The process of claim 3 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

58. The process of claim 4 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

59. The process of claim 7 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

60. The process of claim 10 wherein the manipulated variable capacity of the auxiliary refrigerant

compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

61. The process of claim 13 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

62. The process of claim 18 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

63. The process of claim 23 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

64. The process of claim 25 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

65. The process of claim 27 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.

66. The process of claim 30 wherein the manipulated variable capacity of the auxiliary refrigerant compressor is the speed of the auxiliary refrigerant compressor, the angle of the inlet guide vane of the auxiliary refrigerant compressor, or both.